



# TRITIUM

## USE OF TRITIUM IN ASSESSING AQUIFER VULNERABILITY

Michigan Department of Environmental Quality

This document provides background information on tritium, information on the applicability of tritium analysis in assessing aquifer vulnerability, guidance on the interpretation of tritium results from public water supply wells, and a list of laboratories that provide analysis for tritium. The tritium concentration in ground water provides a useful method for determining the degree of confinement of an aquifer and is identified by the U.S. EPA as an acceptable means of assessing the vulnerability of ground water systems. In summary, tritium levels at or below one tritium unit (TU) are obtained from water supply wells which are "not vulnerable" to contamination.

### BACKGROUND INFORMATION

Tritium is a naturally occurring radioactive isotope of hydrogen, which decays as a beta emitter. It is produced in small quantities in the upper atmosphere where it is incorporated into water molecules and, therefore, present in rainwater and surface recharge to aquifer systems. With a half-life of 12.3 years, tritium can be used to trace and date ground water, calculate rates of water circulation in the hydrologic cycle, and assess how long a specific ground water source has been stored out of contact with tritium laden recharge.

In comparison to many other atmospheric radioactive isotopes, tritium is extremely rare and not affected by chemical processes. The naturally occurring tritium level in rainwater (pre-bomb) is estimated at 5 to 10 tritium unit (TU), where one TU = one Tritium atom per  $10^{18}$  Hydrogen atoms and an equivalent gross beta radiation 3.2 picocuries/liter. However, the amount of tritium in the atmosphere was greatly increased as a result of nuclear weapons testing causing recharge waters to be "tagged" with excess tritium beginning in about 1954. Nuclear weapons testing resulted in atmospheric tritium levels in excess of 1000 TU. Modern day values have declined to levels between 50 and 100 TU with the decline attributed to the elimination of atmospheric nuclear weapons testing and radioactive decay.

### RELATIONSHIP TO GROUND WATER SYSTEM EVALUATION

Tritium analysis may be used to estimate the time since recharge to the ground water system occurred and the susceptibility of the ground water system to contamination. Ground water systems with recharge occurring prior to the 1950's will have a tritium level decreased by radioactive decay to levels at or below one TU. These ground water systems are considered "not vulnerable." Conversely, ground water systems which have been recharged after the early 1950's will contain tritium levels at, or significantly above, the natural "pre-bomb" background concentrations and are considered "vulnerable."

### GUIDELINES FOR WELLHEAD PROTECTION

Although tritium levels may indicate an aquifer is "not vulnerable," it is important to realize that a potential for contamination may still exist. Activities that compromise the integrity of the confining unit or activities in the area of ground water recharge could impact the well in the future. These concerns are the impetus for our approach to wellhead protection on wells completed in aquifers that are not vulnerable as indicated by a tritium level less than one TU.

Where tritium levels of one TU or less are obtained, the guidelines for wellhead protection are as follows:

- 1) A confirmatory round of tritium samples will be required on all wells during the next projected period of **peak** use.
- 2) Upon completion of a local wellhead protection program in accordance with item 3 (below), you will be eligible for the maximum reduction in monitoring under the guidelines established for the Michigan Phase II and V monitoring waiver program.

- 3) As part of the local wellhead protection program, it is required that the community implements a well abandonment program. The program should include a generalized search for improperly abandoned wells within a one-mile radius of the wellfield. The search should focus directly on known or potential sites of environmental contamination in the area. Where such wells are identified, they shall be properly sealed in accordance with the Groundwater Quality Control Act, Part 127 of Act 368, P.A. of 1978, as amended and rules.
- 4) A reduction in area for the well abandonment program to less than a one-mile radius may be obtained by providing an approved wellhead protection area delineation.

### TRITIUM SAMPLES AND ANALYSIS

Sampling for tritium is not difficult since few, if any, chemical processes will alter its concentration. However, since tritium is naturally occurring, it must be assumed that excessive exposure of the sample to the atmosphere might alter the tritium concentration.

One other factor must be considered when conducting a sampling regime for tritium analysis. For the acquisition of meaningful data, the required sensitivity in the analysis is very low (<one TU). Tritium is measured by the liquid scintillation method and generally conducted on concentrated samples after "sample enrichment." While many labs are equipped to measure tritium levels by the liquid scintillation method, few are equipped to conduct the necessary sample enrichment and obtain a one TU detection level. The sample enrichment process takes about four weeks so expect a minimum six-week turn around time between sampling and obtaining results. The laboratories known to provide tritium analysis and the required level of detection are as follows:

Tritium Laboratory University of Miami/RSMAS 4600 Rickenbacker Causeway Miami, Florida 33149-1098 Phone 305-421-4100 Fax 305-421-4112 <a href="http://www.rsmas.miami.edu/groups/tritium/">www.rsmas.miami.edu/groups/tritium/</a> Tritium@rsmas.miami.edu Cost: \$325.00  <b>Updated September 7, 2007</b>	Isotech Laboratories, Inc. 1308 Parkland Court Champaign, Illinois 61821 Telephone: 877-362-4190 or 217-398-3490 Fax: 217-398-3493 <a href="http://www.isotechlabs.com/">http://www.isotechlabs.com/</a> Cost: \$300.00  <b>Updated September 28, 2007</b>
Mary Ellen Patton, Administrator Environmental Isotope Laboratory University of Waterloo 200 University Avenue, West Waterloo, Ontario N2L-3G1 General line: 519-888-4732 Direct line: 519-888-4567 <a href="http://www.uweilab.ca">www.uweilab.ca</a> mepatton@uwaterloo.ca Cost: \$190.00 Canadian Dollars (Lab cannot invoice in U.S. dollars)  <b>Updated September 28, 2007</b>	Center for Applied Isotope Studies University of Georgia 120 Riverbend Road Athens, GA 30602 Telephone: 706-542-1395 Fax: 706-542-6106 <a href="http://www.uga.edu/~cais/index.htm">http://www.uga.edu/~cais/index.htm</a> Email: <a href="mailto:cais@uga.edu">cais@uga.edu</a> See website for shipping address Cost: \$320.00  <b>Updated September 28, 2007</b>

If you have any comments or questions regarding tritium, please contact Brant Fisher at (517) 241-1415.